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59-32U4-4-31

Final report for USDA project on

"DIOXINS IN THE GREAT LAKES FOOD CHAIN"

Project: 59-32U4-4-31 "The study of anaerobic microorganisms which are capable of dehalogenating aromatic organics"

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Approach: We have found that certain anaerobic bacteria found in sediments and anaerobic sludge can remove chlorine from aromatic compounds, thereby making these chemicals less toxic and persistant. This reductive dehalogenation seems to be carried out by a newly discovered group of anaerobic bacteria. Our approach has been first to study the dechlorination mechanism for the chlorinated benzoate and chlorinated phenol classes of chemicals and the chlorobenzene class. The benzene class is the one which is most closely related to dioxin in chemical properties. This year has focused on determining whether hexachlorobenzene could be dehalogenated by samples containing anaerobic bacteria, and on preparation of a new method to study dechlorination of dioxin.

Results: We have incubated hexachlorobenzene with anaerobic bacteria obtained from a municipal sludge digestor which had previously shown the ability to dehalogenate chlorinated phenols. The hexachlorobenzene was dechlorinated as evidenced by the transient accumulation of 1,3,5-trichlorobenzene. The same samples which have been autoclaved showed no decrease in the hexachlorobenzene concentration. In the active samples, further dechlorination to give dichlorobenzene, chlorobenzene and benzene is probable, however, these

intermediates are easily lost by volatilization. These positive results on hexachlorobenzene are encouraging because it shows that dechlorination also occurs with non-polar aromatic chemicals and suggests the possibility that chlorinated dioxins may also undergo dechlorination reactions.

We have developed a new method for the study of dechlorination of dioxin. This involves labelling dioxin with ^{36}Cl and measuring the release of ^{36}Cl chloride ion. This is a much more sensitive measure for dechlorination than trying to extract the substrate (dioxin) and is far less hazardous to the investigator. It will also be much easier to study whether chlorination of low concentrations occurs in sediments representative of the Great Lakes inflow streams. At the end of this year we obtained the ^{36}Cl-labelled 2,3,7,8-TCDD from New England Nuclear. We have also established our analytical protocol for separating and quantitating ^{36}Cl-chloride ion in our various anaerobic systems. We have shown complete separation of ^{36}Cl-chloride and TCDD by tracing both add ^{36}Cl-chloride and ^{14}C-TCDD. At this point we are incubating the ^{36}Cl-TCDD in the following anaerobic communities.

1. Anaerobic sediment for the Tittabawassee River which has had previous exposure to TCDD.
2. Anaerobic sediment from the Hudson River which is believed to be actively dechlorinating PCB's.
3. Sludge and sediment enrichments which dechlorinate Cl-benzoates.
4. Sludge enrichment which dechlorinates 1-, 2-, and 3-chlorophenols, and pentachlorophenol.
5. Sludge which dechlorinates hexachlorobenzene.

These studies will establish whether (1) the anaerobic bacteria we how have can be used to detoxify TCDD via dechlorination reactions, and (2) whether sediments, including those contaminated with TCDD, have the capacity

to be detoxified under natural conditions via dechlorination reactions carried out by the indigenous microflora.

Personnel: M. Mikesell, B. Fathepure

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Inventions: None

Signatures

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